UNITED STATES PATENT AND TRADEMARK OFFICE

UNITED STATES DEPARTMENT OF COMMERCE
United States Patent and Trademark Office
Address: COMMISSIONER FOR PATENTS
P.O. Box 1450
Alexandria, Virginia 22313-1450
www.uspto.gov

APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
10/534,158	05/05/2005	Claas Bontus	PHDE020244US	2602

38107 7590 05/16/2008
PHILIPS INTELLECTUAL PROPERTY & STANDARDS
595 MINER ROAD
CLEVELAND, OH 44143

EXAMINER	
CORBETT, JOHN M	

ART UNIT	PAPER NUMBER
2882	

MAIL DATE	DELIVERY MODE
05/16/2008	PAPER

Please find below and/or attached an Office communication concerning this application or proceeding.

The time period for reply, if any, is set in the attached communication.

Office Action Summary	Application No.	Applicant(s)	
	10/534,158	BONTUS ET AL.	
	Examiner	Art Unit	
	JOHN M. CORBETT	2882	

-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address --

Period for Reply

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE *3* MONTH(S) OR THIRTY (30) DAYS, WHICHEVER IS LONGER, FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136(a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133). Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

Status

1)☒ Responsive to communication(s) filed on *23 January 2008*.

2a)☐ This action is **FINAL**. 2b)☒ This action is non-final.

3)☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

Disposition of Claims

4)☒ Claim(s) *1-20* is/are pending in the application.

4a) Of the above claim(s) _____ is/are withdrawn from consideration.

5)☐ Claim(s) _____ is/are allowed.

6)☒ Claim(s) *1-20* is/are rejected.

7)☐ Claim(s) _____ is/are objected to.

8)☐ Claim(s) _____ are subject to restriction and/or election requirement.

Application Papers

9)☒ The specification is objected to by the Examiner.

10)☒ The drawing(s) filed on *23 January 2008* is/are: a)☒ accepted or b)☐ objected to by the Examiner.

Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).

Replacement drawing sheet(s) including the correction is required if the drawing(s) is objected to. See 37 CFR 1.121(d).

11)☐ The oath or declaration is objected to by the Examiner. Note the attached Office Action or form PTO-152.

Priority under 35 U.S.C. § 119

12)☒ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).

a)☒ All b)☐ Some * c)☐ None of:

1.☐ Certified copies of the priority documents have been received.

2.☐ Certified copies of the priority documents have been received in Application No. _____.

3.☒ Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).

* See the attached detailed Office action for a list of the certified copies not received.

Attachment(s)

1) ☒ Notice of References Cited (PTO-892)

2) ☐ Notice of Draftsperson's Patent Drawing Review (PTO-948)

3) ☐ Information Disclosure Statement(s) (PTO/SB/08) Paper No(s)/Mail Date _____.

4) ☐ Interview Summary (PTO-413) Paper No(s)/Mail Date. _____ .

5) ☐ Notice of Informal Patent Application

6) ☐ Other: _____.

DETAILED ACTION

Specification

1. The disclosure is objected to because of the following informalities:

On page 10, line 27 "Fig. 6" is disclosed. Perhaps "Fig. 8" was meant.

Appropriate correction is required.

Claim Rejections - 35 USC § 102

The following is a quotation of the appropriate paragraphs of 35 U.S.C. 102 that form the basis for the rejections under this section made in this Office action:

> A person shall be entitled to a patent unless –
>
> (b) the invention was patented or described in a printed publication in this or a foreign country or in public use or on sale in this country, more than one year prior to the date of application for patent in the United States.
>
> (e) the invention was described in (1) an application for patent, published under section 122(b), by another filed in the United States before the invention by the applicant for patent or (2) a patent granted on an application for patent by another filed in the United States before the invention by the applicant for patent, except that an international application filed under the treaty defined in section 351(a) shall have the effects for purposes of this subsection of an application filed in the United States only if the international application designated the United States and was published under Article 21(2) of such treaty in the English language.

2. Claims 6-11 and 14-19 are rejected under 35 U.S.C. 102(b) as being anticipated by Katsevich ("Analysis of an exact inversion algorithm for spiral cone-beam CT", 7 August 2002, Phys. Med. Biol., Volume 42, Pages 2583-2597).

With respect to claim 6, Katsevich (2002) discloses a method, comprising:

producing measuring values indicative of radiation that traverses an examination zone and is detected by a radiation sensitive detector (Title, Abstract, Page 2584, Equations 1 and 2, and Page 2589, lines 25-34); and

reconstructing the measuring values (Abstract, image of phantom reconstructed) as a function of corresponding projection angles to generate an image indicative of the examination zone (Abstract, Pages 2584-2586, Section 2. The main inversion formula, Pages 2586-2587, Section 3 Two particular cases of the inversion formula, including Theorem 2, Equation 15 and Figure 2).

With respect to claim 7, Katsevich (2002) further discloses a projection angle is the angle enclosed by a PI line of an object point projected in a plane perpendicular to an axis of rotation (Abstract, Pages 2584-2586, Section 2. The main inversion formula, Pages 2586-2587, Section 3 Two particular cases of the inversion formula, including Theorem 2, Equation 15 and Figure 2).

With respect to claim 8, Katsevich (2002) further discloses determining a partial derivative of the measuring values (Abstract, Pages 2584-2586, Section 2. The main inversion formula, Pages 2586-2587, Section 3 Two particular cases of the inversion formula, including Theorem 2, Equation 15 and Figure 2);

performing a weighted-integration of the partial derivative (Abstract, Pages 2584-2586, Section 2. The main inversion formula, Pages 2586-2587, Section 3 Two particular cases of the inversion formula, including Theorem 2, Equation 15 and Figure 2); and

reconstructing the integrated partial derivative to generate the image (Abstract, image of phantom reconstructed).

With respect to claim 9, Katsevich (2002) further discloses the partial derivative is integrated along K lines (Abstract, Pages 2584-2586, Section 2. The main inversion formula, Pages 2586-2587, Section 3 Two particular cases of the inversion formula, including Theorem 2, Equation 15 and Figure 2).

With respect to claim 10, Katsevich (2002) further discloses performing the weighted-integrating the partial derivative of the measuring values, includes:

determining a K plane for each radiation source position and each location to be reconstructed in the examination zone (Abstract, Pages 2584-2586, Section 2. The main inversion formula, Pages 2586-2587, Section 3 Two particular cases of the inversion formula, including Theorem 2, Equation 15 and Figure 2);

determining K lines, wherein K lines include lines of intersection between the K planes and a detector surface of the radiation sensitive detector (Abstract, Pages 2584-2586, Section 2. The main inversion formula, Pages 2586-2587, Section 3 Two particular cases of the inversion formula, including Theorem 2, Equation 15 and Figure 2);

necessarily multiplying the partial derivative of the measuring values on each K line by a weighting factor that corresponds to a reciprocal value of a sine of a K angle (including Pages 2584-2586, Section 2. The main inversion formula and Figure 1); and

integrating the partial derivative of the measuring values along the K lines (including Pages 2584-2586, Section 2. The main inversion formula and Figure 1).

With respect to claim 11, Katsevich (2002) further discloses prior to the reconstruction step, multiplying the integrated partial derivative by the same weighting factor (Abstract, Pages 2584-2586, Section 2. The main inversion formula, Pages 2586-2587, Section 3 Two particular cases of the inversion formula, including Theorem 2, Equation 15 and Figure 2).

With respect to claim 14, Katsevich (2002) further discloses reconstructing the measuring values includes reconstructing the measuring values as a function of the following:

$$-\frac{1}{2\pi^2}\int_0^{\pi} d\varphi p(y(s(\varphi)),\Phi(s(\varphi),x))\text{, wherein,}$$

$p(y(s(\varphi)),\Phi(s(\varphi),x))$ denotes a weighted integration of a partial derivative of the measuring values,

$\int_0^{\pi} d\varphi$ denotes an integration over the projection angles φ,

λ denotes a cone angle of the radiation beam;

ε denotes a fan angle of the radiation beam;

R denotes a radius of the helical trajectory;

x denotes a location in the examination zone;

s(φ) denotes a parameter that is a function of φ;

y(s) denotes a function that indicates the radiation source position along a helical trajectory and is dependent upon the parameter s; and

Φ denotes a unity factor which points from the radiation source position y(s) in the direction of x (Abstract, Pages 2584-2586, Section 2. The main inversion formula, Pages 2586-2587, Section 3 Two particular cases of the inversion formula, including Theorem 2, Equation 15 and Figure 2).

With respect to claim 15, Katsevich (2002) discloses a method, comprising:

identifying a first voxel from a plurality of voxels within an examination zone to reconstruct (Abstract, Pages 2584-2586, Section 2. The main inversion formula, Pages 2586-2587, Section 3 Two particular cases of the inversion formula, including Theorem 2, Equation 15 and Figure 2); and

reconstructing the first voxel as a function of a first set of corresponding projection angles indicative of angles at which a radiation beam traverses the first voxel (Abstract, Pages 2584-2586, Section 2. The main inversion formula, Pages 2586-2587, Section 3 Two particular cases of the inversion formula, including Theorem 2, Equation 15 and Figure 2).

With respect to claim 16, Katsevich (2002) further discloses reconstructing at least a second voxel, from the plurality of voxels, as a function of a second set of corresponding projection angles indicative of angles at which the radiation beam traverses the second voxel (Abstract, Pages 2584-2586, Section 2. The main inversion formula, Pages 2586-2587, Section 3 Two particular cases of the inversion formula, including Theorem 2, Equation 15 and Figure 2).

With respect to claim 17, Katsevich (2002) discloses a system, comprising:

a detector that detects radiation from a conical radiation beam traversing an examination zone and that generates measuring values indicative of the detected radiation (Page 2589, lines 25-34); and

a reconstructor (a computed tomography system necessarily has a computer to reconstruct images including the inversion formulas as outlined in sections including sections 2 and 3) that integrates the measuring values over projection angles corresponding to angles enclosed by a PI line of an object point projected in a plane perpendicular to an axis of rotation (Abstract, Pages 2584-2586, Section 2. The main inversion formula, Pages 2586-2587, Section 3 Two particular cases of the inversion formula, including Theorem 2, Equation 15 and Figure 2).

With respect to claim 18, Katsevich (2002) further discloses the reconstructor determines a partial derivative of the measuring values, performs a weighted integration of the partial derivative, and integrates the weighted-integration of the partial derivative of the measuring values (Abstract, Pages 2584-2586, Section 2. The main inversion formula, Pages 2586-2587, Section 3 Two particular cases of the inversion formula, including Theorem 2, Equation 15 and Figure 2).

With respect to claim 19, Katsevich (2002) further discloses the weighted integration, includes:

determining a K plane for each radiation source position and each location to be reconstructed in the examination zone (Abstract, Pages 2584-2586, Section 2. The main

inversion formula, Pages 2586-2587, Section 3 Two particular cases of the inversion formula, including Theorem 2, Equation 15 and Figure 2);

determining lines of intersection between the K planes and a detector surface of the detector, wherein the lines of intersection are K lines (Abstract, Pages 2584-2586, Section 2. The main inversion formula, Pages 2586-2587, Section 3 Two particular cases of the inversion formula, including Theorem 2, Equation 15 and Figure 2);

multiplying the partial derivative of the measuring values on each line of intersection by a weighting factor that corresponds to a reciprocal value of a sine of a K angle (including Pages 2584-2586, Section 2. The main inversion formula and Figure 1); and

integrating the partial derivative of the measuring values along the lines of intersection (including Pages 2584-2586, Section 2. The main inversion formula and Figure 1).

Note: K plane corresponds to Π plane. K lines correspond to family of lines.

3. Claim 6 is rejected under 35 U.S.C. 102(b) as being anticipated by Turbell et al. ("An improved PI-method for reconstruction for helical cone-beam projections", 24-30 October 1999, Nuclear Science Symposium, 1999, IEEE, pages 865-868).

With respect to claim 6, Turbell et al. (p865) teaches a method, comprising:

producing measuring values indicative of radiation that traverses an examination zone and is detected by a radiation sensitive detector (Figure 1); and

reconstructing the measuring values as a function of corresponding projection angles to generate an image indicative of the examination zone (including Step 4 of introduction and Figures 6-8).

4. Claims 6-11 and 15-19 are rejected under 35 U.S.C. 102(e) as being anticipated by Katsevich (6,574,299).

With respect to claim 6, Katsevich teaches a method, comprising:

producing measuring values (including $D_f(y,\Theta)$) indicative of radiation that traverses an examination zone and is detected by a radiation sensitive detector (including Figure 1); and

reconstructing the measuring values as a function of corresponding projection angles to generate an image indicative of the examination zone (including Col. 1, lines 5-9).

With respect to claim 7, Katsevich ('299) further teaches wherein a projection angle (including parameter s) is the angle enclosed by a PI line (including Col. 5, lines 36-44 and Figure 4) of an object point (x) projected in a plane perpendicular to an axis of rotation (including Equation 1 for y_1 and y_2).

With respect to claim 8, Katsevich ('299) further teaches

determining a partial derivative (including Step 35) of the measuring values;

performing a weighted-integration of the partial derivative (including Equations 10 and 12, $1/\sin\gamma$ term and equation 10, $1/|x-y(s)|$ term); and

reconstructing the integrated partial derivative to generate the image (including Step 50 and items 4 and 6).

With respect to claim 9, Katsevich ('299) further teaches wherein the partial derivative is integrated (including Equation 10) along K lines (including Col. 7. lines 5-11).

Note: K plane corresponds to Π plane. K lines correspond to family of lines.

With respect to claim 10, Katsevich ('299) further teaches wherein performing the weighted-integrating the partial derivative of the measuring values, includes:

determining a K plane for each radiation source position and each location to be reconstructed in the examination zone (including Col. 7, lines 5-11 and Step 20);

determining K lines, wherein K lines include lines of intersection between the K planes and a detector surface of the radiation sensitive detector (including Col. 7, lines 5-11 and Step 20);

multiplying the partial derivative of the measuring values on each K line by a weighting factor that corresponds to a reciprocal value of a sine of a K angle (including Steps 43-44); and

integrating the partial derivative of the measuring values along the K lines (including Equations 10, 12-13 and 16).

Note: K plane corresponds to Π plane. K lines correspond to family of lines.

With respect to claim 11, Katsevich ('299) further teaches prior to the reconstruction step, multiplying the integrated partial derivative by the same weighting factor (including Equations 12-13, distance weighting factor outside of integral of partial derivative).

With respect to claim 15, Katsevich ('299) teaches a method, comprising:

identifying a first voxel from a plurality of voxels within an examination zone to reconstruct (including Step 51 where x is voxel in 3D reconstruction); and

reconstructing the first voxel as a function of a first set of corresponding projection angles indicative of angles at which a radiation beam traverses the first voxel (including Step 50 and Figure 2).

With respect to claim 16, Katsevich ('299) further teaches further including reconstructing at least a second voxel (including Step 58), from the plurality of voxels, as a function of a second set of corresponding projection angles indicative of angles at which the radiation beam traverses the second voxel (including Step 50 and Figure 2).

With respect to claim 17, Katsevich ('299) teaches a system, comprising:

a detector that detects radiation from a conical radiation beam traversing an examination zone and that generates measuring values indicative of the detected radiation (including Col. 4, lines 3-13 and Figure 1); and

a reconstructor (4) that integrates the measuring values over projection angles corresponding to angles enclosed by a PI line (including Col. 5, lines 36-44 and Figure 4) of an

object point (x) projected in a plane perpendicular to an axis of rotation (including Equation 1 for y_1 and y_2).

With respect to claim 18, Katsevich ('299) further teaches wherein the reconstructor

determines a partial derivative (including Step 35) of measuring values ($D_f(y,\Theta)$),

performs a weighted (including distance weighting $1/|x-y(s)|$) integration of the partial derivative (including Equation 10), and

integrates the weighted-integration of the partial derivative of the measuring values (including Equation 10).

With respect to claim 19, Katsevich ('299) further teaches wherein the weighted integration, includes:

determining a K plane for each radiation source position and each location to be reconstructed in the examination zone (including Col. 7, lines 5-11 and Step 20);

determining lines of intersection between the K planes and a detector surface of the detector, wherein the lines of intersection are K lines (including Col. 7, lines 5-11 and Step 20);

multiplying the partial derivative of the measuring values on each line of intersection by a weighting factor that corresponds to a reciprocal value of a sine of a K angle (including Steps 43-44); and

integrating the partial derivative of the measuring values along the lines of intersection (including Equations 10, 12-13 and 16).

Note: K plane corresponds to Π plane. K lines correspond to family of lines.

Claim Rejections - 35 USC § 103

The following is a quotation of 35 U.S.C. 103(a) which forms the basis for all obviousness rejections set forth in this Office action:

> (a) A patent may not be obtained though the invention is not identically disclosed or described as set forth in section 102 of this title, if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains. Patentability shall not be negatived by the manner in which the invention was made.

5. Claims 1, 3, 12-13 and 20 are rejected under 35 U.S.C. 103(a) as being unpatentable over Katsevich (2002) as respectively applied to claims 8 and 6 above.

With respect to claim 1, Katsevich (2002) discloses a computed tomography method (Title) which comprises the steps of:

generating, using a radiation source (Page 2589, line 25 and Figure 1), a conical radiation beam (Title) which traverses an examination zone or an object present therein (Page 2589, line 34),

generating a relative motion of the radiation source about the examination zone, which relative motion comprises a rotation about an axis of rotation and a displacement parallel to the axis of rotation and is shaped as a helix (Page 2589, line 25 and Figure 1),

acquiring measuring values which are dependent on the intensity of the radiation beam that traverses the examination zone and is incident on of a detector unit during the relative motions (Title, Abstract, Page 2584, Equations 1 and 2, and Page 2589, lines 25-34),

reconstructing a CT image of the examination zone from the measuring values, in which reconstruction of an exact 3D back projection comprising the following steps is carried out:

determining the partial derivative of measuring values of parallel rays with different radiation source positions in conformity with the angular position of the radiation source (Pages 2584-2586, Section 2. The main inversion formula),

performing a weighted integration of the partial derivative of the measuring values along K lines source (Pages 2584-2586, Section 2. The main inversion formula), and

reconstructing the absorption of each object point by back projection of the weighted, integrated partial derivative of the measuring values (including Abstract, image of phantom reconstructed).

Katsevich (2002) fails to explicitly disclose multiplying the integrated partial derivative of the measuring values by a first weighting factor which corresponds to the cosine of the cone angle of the ray associated with the measuring values and, by a second weighting factor which corresponds to the reciprocal value of the cosine of a fan angle of the beam associated with the measuring values, (i.e., a scalar form of the inversion formula).

Katsevich (2002) further discloses a vector form of the inversion formula following a change of variables (Abstract, Pages 2586-2587, Section 3 Two particular cases of the inversion formula, including Theorem 2, Equation 15 and Figure 2).

It would have been obvious to one of ordinary skill in the art at the time the invention was made to modify the method of Katsevich (2002) to include the scalar form of the inversion formula since the two forms are art recognized equivalents and the selection of any two of these

known forms would have been within the level of ordinary skill in the art. A person would have been motivated to make such a modification to more easily implement the reconstruction algorithm on a computer.

Note: K plane corresponds to Π plane. K lines correspond to family of lines.

With respect to claim 3, Katsevich (2002) discloses a computed tomography method which comprises the steps of:

generating, using a radiation source (Page 2589, line 25 and Figure 1), a conical radiation beam (Title) which traverses an examination zone or an object present therein (Page 2589, line 34),

generating a relative motion of the radiation source about the examination zone, which relative motion comprises a rotation about an axis of rotation and a displacement parallel to the axis of rotation and is shaped as a helix (Page 2589, line 25 and Figure 1),

acquiring measuring values which are dependent on the intensity of the radiation beam that traverses the examination zone and is incident on a detector unit during the relative motions (Title, Abstract, Page 2584, Equations 1 and 2, and Page 2589, lines 25-34); and

reconstructing a CT image of the examination zone from the measuring values, in which reconstruction of an exact 3D back projection comprising the following steps is carried out:

determining the partial derivative of measuring values of parallel rays with different radiation source positions in conformity with the angular position of the radiation source (Pages 2584-2586, Section 2. The main inversion formula);

performing a weighted-integration of the partial derivative of the measuring values along K lines (Pages 2584-2586, Section 2. The main inversion formula);

reconstructing the absorption of each object point by back projection of the weighted, integrated partial derivative of the measuring values (Abstract, image of phantom reconstructed), wherein the weighted-integration of the measuring values along the K lines comprises the following steps:

determining a K plane for each radiation source position and each location to be reconstructed in the examination zone (including Pages 2584-2586, Section 2. The main inversion formula and Figure 1),

determining the K lines, wherein the K lines are lines of intersection between the K planes and a detector surface of the detector unit (including Pages 2584-2586, Section 2. The main inversion formula and Figure 1),

multiplying the partial derivative of the measuring values on each K line by a weighting factor which corresponds to the reciprocal value of the sine of a K angle (including Pages 2584-2586, Section 2. The main inversion formula and Figure 1), and

integrating the partial derivative of the measuring values along the K lines (including Pages 2584-2586, Section 2. The main inversion formula).

Katsevich (2002) fails to explicitly disclose multiplying the integrated partial derivative of the measuring values by a first weighting factor which corresponds to the cosine of the cone angle of the ray associated with the measuring values and by a second weighting factor which

corresponds to the reciprocal value of the cosine of a fan angle of the beam associated with the measuring values (i.e., a scalar form of the inversion formula).

Katsevich (2002) further discloses a vector form of the inversion formula following a change of variables (Abstract, Pages 2586-2587, Section 3 Two particular cases of the inversion formula, including Theorem 2, Equation 15 and Figure 2).

It would have been obvious to one of ordinary skill in the art at the time the invention was made to modify the method of Katsevich (2002) to include the scalar form of the inversion formula since the two forms are art recognized equivalents and the selection of any two of these known forms would have been within the level of ordinary skill in the art. A person would have been motivated to make such a modification to more easily implement the reconstruction algorithm on a computer.

Note: K plane corresponds to Π plane. K lines correspond to family of lines.

With respect to claim 12, Katsevich (2002) discloses the method as recited above.

Katsevich (2002) fails to explicitly disclose prior to the reconstruction step:

multiplying the integrated partial derivative of the measuring values by the cosine of a cone angle of the radiation beam; and

dividing the integrated partial derivative of the measuring values by the cosine of a fan angle of the radiation beam (i.e., a scalar form of the inversion formula).

Katsevich (2002) further discloses a vector form of the inversion formula following a change of variables (Abstract, Pages 2586-2587, Section 3 Two particular cases of the inversion formula, including Theorem 2, Equation 15 and Figure 2).

It would have been obvious to one of ordinary skill in the art at the time the invention was made to modify the method of Katsevich (2002) to include the scalar form of the inversion formula since the two forms are art recognized equivalents and the selection of any two of these known forms would have been within the level of ordinary skill in the art. A person would have been motivated to make such a modification to more easily implement the reconstruction algorithm on a computer.

With respect to claim 13, Katsevich (2002) discloses the method as recited above.

Katsevich (2002) fails to explicitly disclose reconstructing the measuring values includes reconstructing the measuring values as a function of the following:

$$-\frac{1}{2\pi^2}\int_0^{\pi} d\varphi \frac{\cos\lambda}{R\cos\varepsilon} p(y(s(\varphi)), \Phi(s(\varphi), x))$$, wherein,

$p(y(s(\varphi)), \Phi(s(\varphi), x))$ denotes a weighted integration of a partial derivative of the measuring values,

$\frac{\cos\lambda}{R\cos\varepsilon}$ denotes a weighting factor,

$\int_0^{\pi} d\varphi$ denotes an integration over the projection angles φ,

λ denotes a cone angle of the radiation beam;

ε denotes a fan angle of the radiation beam;

R denotes a radius of the helical trajectory;

x denotes a location in the examination zone;

$s(\varphi)$ denotes a parameter that is a function of φ;

y(s) denotes a function that indicates the radiation source position along a helical trajectory and is dependent upon the parameter s; and

Φ denotes a unity factor which points from the radiation source position y(s) in the direction of x (i.e., a scalar form of the inversion formula).

Katsevich (2002) further discloses a vector form of the inversion formula following a change of variables (Abstract, Pages 2586-2587, Section 3 Two particular cases of the inversion formula, including Theorem 2, Equation 15 and Figure 2).

It would have been obvious to one of ordinary skill in the art at the time the invention was made to modify the method of Katsevich (2002) to include the scalar form of the inversion formula since the two forms are art recognized equivalents and the selection of any two of these known forms would have been within the level of ordinary skill in the art. A person would have been motivated to make such a modification to more easily implement the reconstruction algorithm on a computer.

With respect to claim 20, Katsevich (2002) as modified above further discloses including multiplying the integrated partial derivative of the measuring values by a first weighting factor which corresponds to the cosine of the cone angle of the ray associated with the measuring values, a second weighting factor which corresponds to the reciprocal value of the cosine of a fan angle of the beam associated with the measured values, and a third weighting factor which corresponds to an inverse of a radius of the helix (including Abstract, Pages 2586-2587, Section 3 Two particular cases of the inversion formula, Theorem 2, Equation 15 and Figure 2).

6. Claim 2 is rejected under 35 U.S.C. 103(a) as being unpatentable over Katsevich (2002) as applied to claim 1 above, and further in view of Turbell et al. ("Non-Redundant Data Capture and Efficient Reconstruction for Helical Cone-Beam CT", 1999, IEEE, Pages 1424-1425).

With respect to claim 2, Katsevich (2002) as modified above suggests the method as recited above. Katsevich (2002) fails to disclose in the reconstruction step further includes rebinning of the weighted, integrated partial derivative of the measuring values is performed prior to the back projection so as to form a number of groups, each group comprising a plurality of planes which extend parallel to one another and to the axis of rotation and in which a respective fan beam is situated.

Turbell et al. (p1424) teaches in the reconstruction step further includes rebinning (including Step II. A.) of the weighted, integrated partial derivative of the measuring values is performed prior to the back projection (including Step II. C) so as to form a number of groups, each group comprising a plurality of planes which extend parallel to one another and to the axis of rotation and in which a respective fan beam is situated (including Step II. A. and Figure 2).

It would have been obvious to one of ordinary skill in the art at the time the invention was made to include in the method of Katsevich (2002) as modified above to include the rebinning of Turbell et al. (p1424), since a person would have been motivated to make such a modification to improve imaging by reducing computation times by utilizing a computationally efficient reconstruction algorithm (Abstract) as taught by Turbell et al. (p1424).

7. Claim 4 is rejected under 35 U.S.C. 103(a) as being unpatentable over Katsevich (2002) in view of Hsieh (6,529,575).

With respect to claim 4, Katsevich (2002) discloses a computer tomograph comprising:

a radiation source (including Page 2589, line 25 and Figure 1) in order to generate a radiation beam which traverses an examination zone or an object present therein (including Page 2589, line 34),

a detector unit which is coupled to the radiation source (including Page 2589, lines 25-34),

necessarily a drive arrangement which serves to displace an object present in the examination zone and the radiation source relative to one another about an axis of rotation and/or parallel to the axis of rotation (including Title, Abstract, Page 2584, Equations 1 and 2, and Page 2589, lines 25-34),

a reconstruction unit configured to reconstruct the spatial distribution of the absorption within the examination zone from measuring values acquired by the detector unit (including a computed tomography system necessarily has a computer to reconstruct images including the inversion formulas as outlined in sections including sections 2 and 3),

a control unit configured to control the radiation source, the detector unit, the drive arrangement and the reconstruction unit (including a computed tomography system necessarily has a control unit to sequential control the steps of performing the data acquisition and reconstruction process via a computer) in conformity with the steps of

determining the partial derivative of measuring values of parallel rays with different radiation source positions in conformity with the angular position of the radiation source (including Pages 2584-2586, Section 2. The main inversion formula);

performing a weighted-integration of the partial derivative of the measuring values along K lines (including Pages 2584-2586, Section 2. The main inversion formula); and

reconstructing the absorption of each object point by back projection of the weighted, integrated partial derivative of the measuring values (including Abstract, image of phantom reconstructed).

Katsevich (2002) fails to explicitly disclose multiplying the integrated, derived measuring values by a first weighting factor which corresponds to the cosine of the cone angle of the ray associated with the measuring values and by a second weighting factor which corresponds to the reciprocal value of the cosine of a fan angle of the beam associated with the measuring values (i.e., a scalar form of the inversion formula).

Katsevich (2002) further fails to explicitly teach a diaphragm arrangement which is situated between the examination zone and the radiation source.

Katsevich (2002) further discloses a vector form of the inversion formula (Abstract, Pages 2586-2587, Section 3 Two particular cases of the inversion formula, including Theorem 2, Equation 15 and Figure 2).

It would have been obvious to one of ordinary skill in the art at the time the invention was made to modify the apparatus of Katsevich (2002) to include the scalar form of the inversion formula since the two forms are art recognized equivalents and the selection of any two of these

known forms would have been within the level of ordinary skill in the art. A person would have been motivated to make such a modification to more easily implement the reconstruction algorithm on a computer.

Hsieh teaches a diaphragm arrangement which is situated between the examination zone and the radiation source (including Col. 3, lines 63-66).

It would have been obvious to one of ordinary skill in the art at the time the invention was made to include in the apparatus of Katsevich (2002) as modified above the diaphragm arrangement of Hsieh, since a person would have been motivated to make such a modification to minimize patient dose by limiting the x-ray beam to the size of the detector (including Col. 3, line 65 – Col. 4, line 5) as implied by Hsieh.

Note: K plane corresponds to Π plane. K lines correspond to family of lines.

8. Claim 5 is rejected under 35 U.S.C. 103(a) as being unpatentable over Katsevich (2002) as applied to claim 1 above, and further in view of Hsieh.

With respect to claim 5, Katsevich (2002) as modified above suggests the method as recited above. Katsevich (2002) as modified above fails to explicitly teach a diaphragm arrangement. Katsevich (2002) as modified above further fails to explicitly teach a computer-readable medium encoded with a computer program for a control unit for controlling a radiation source, a diaphragm arrangement, a detector unit, a drive arrangement and a reconstruction unit of a computer tomograph so as to execute steps.

Hsieh teaches a diaphragm arrangement (including Col. 3, lines 63-66).

It would have been obvious to one of ordinary skill in the art at the time the invention was made to include in the method of Katsevich (2002) as modified above the diaphragm arrangement of Hsieh, since a person would have been motivated to make such a modification to minimize patient dose by limiting the x-ray beam to the size of the detector (including Col. 3, line 65 – Col. 4, line 5) as implied by Hsieh.

Hsieh teaches a computer-readable medium encoded with a computer program for a control unit for controlling a radiation source, a diaphragm arrangement, a detector unit, a drive arrangement and a reconstruction unit of a computer tomograph so as to execute steps (including Col. 8, line 57 - Col. 9, line 12).

It would have been obvious to one of ordinary skill in the art at the time the invention was made to modify the method of Katsevich (2002) as modified to include the computer-readable medium of Hsieh, since person would have been motivated to make such a modification to more easily update existing systems to implement the invention (Col. 8, line 66 - Col. 9, line 1) as taught by Hsieh.

9. Claims 7-11 are rejected under 35 U.S.C. 103(a) as being unpatentable over Turbell et al. (p865) as applied to claim 6 above, and further in view of Katsevich ('299).

With respect to claims 7 and 8, Turbell et al. (p865) discloses the method as recited above. Turbell et al. (p865) fails to teach

wherein a projection angle is the angle enclosed by a PI line of an object point projected in a plane perpendicular to an axis of rotation;

determining a partial derivative of the measuring values;

performing a weighted-integration of the partial derivative; and

reconstructing the integrated partial derivative to generate the image.

Katsevich ('299) teaches wherein a projection angle (parameter s) is the angle enclosed by a PI line (including Col. 5, lines 36-44 and Figure 4) of an object point (x) projected in a plane perpendicular to an axis of rotation (including Equation 1 for y_1 and y_2);

determining a partial derivative (including Step 35) of the measuring values;

performing a weighted-integration of the partial derivative (including Equations 10 and 12, $1/\sin\gamma$ term and equation 10, $1/|x-y(s)|$ term); and

reconstructing the integrated partial derivative to generate the image (including Step 50 and items 4 and 6).

It would have been obvious to one of ordinary skill in the art at the time the invention was made to modify the method of Turbell et al. (p865) to include the features of Katsevich ('299), since a person would have been motivated to make such a modification to produce exact images with reduced scanning times (Col. 2, lines 24-46) as taught by Katsevich ('299).

With respect to claim 9, Katsevich ('299) further teaches wherein the partial derivative is integrated (including Equation 10) along K lines (including Col. 7. lines 5-11).
Note: K plane corresponds to Π plane. K lines correspond to family of lines.

With respect to claim 10, Katsevich ('299) further teaches wherein performing the weighted-integrating the partial derivative of the measuring values, includes:

determining a K plane for each radiation source position and each location to be reconstructed in the examination zone (including Col. 7, lines 5-11 and Step 20);

determining K lines, wherein K lines include lines of intersection between the K planes and a detector surface of the radiation sensitive detector (including Col. 7, lines 5-11 and Step 20);

multiplying the partial derivative of the measuring values on each K line by a weighting factor that corresponds to a reciprocal value of a sine of a K angle (including Steps 43-44); and

integrating the partial derivative of the measuring values along the K lines (including Equations 10, 12-13 and 16).

Note: K plane corresponds to Π plane. K lines correspond to family of lines.

With respect to claim 11, Katsevich ('299) further teaches prior to the reconstruction step, multiplying the integrated partial derivative by the same weighting factor (including Equations 12-13, distance weighting factor outside of integral of partial derivative).

10. Claims 12 and 13 are rejected under 35 U.S.C. 103(a) as being unpatentable over Turbell et al. (p865) in view of Katsevich ('299) as applied to claims 8 and 6 above respectively, and further in view of Zeng et al. (5,559,335).

With respect to claim 12, Turbell et al. (p865) as modified above suggests the method as recited above. Turbell et al. (p865) further teaches prior to the reconstruction step: multiplying

the measuring values by the cosine of a cone angle of the radiation beam (including Page 865, step 1 of introduction).

Turbell et al. (p865) as modified above fails to explicitly teach dividing the measuring values by the cosine of a fan angle of the radiation beam.

Zeng et al. teaches dividing the measuring values by the cosine of a fan angle of the radiation beam (including Col. 4, lines 45-46 and 52-56).

It would have been obvious to one of ordinary skill in the art at the time the invention was made to include in the method of Turbell et al. (p865) as modified above the dividing of Zeng et al., since a person would have been motivated to make such a modification to reduce reconstruction times (including Col. 3, lines 2-10) as taught by Zeng et al.

With respect to claim 13, Turbell et al. (p865) discloses the method as recited above. Turbell et al. (p865) further teaches cos λ weighting (including Page 865, step 1 of introduction). Turbell et al. (p865) fails to explicitly teach 1/Rcos ε weighting. Turbell et al. (p865) further fails to teach a weighted integration of a partial derivative of the measuring values and integration over projection angles.

Katsevich ('299) teaches a weighted integration of a partial derivative of the measuring values and 1/R (including Equations 12 and 13) and integration over projection angles (over s).

It would have been obvious to one of ordinary skill in the art at the time the invention was made to modify the method of Turbell et al. (p865) to include the features of Katsevich ('299), since a person would have been motivated to make such a modification to produce exact

images with reduced scanning times (including Col. 2, lines 24-46) as taught by Katsevich ('299).

Zeng et al. teaches 1/cos ε weighting (including Col. 4, lines 45-46 and 52-56).

It would have been obvious to one of ordinary skill in the art at the time the invention was made to include in the method of Turbell et al. (p865) as modified above the weighting of Zeng et al., since a person would have been motivated to make such a modification to reduce reconstruction times (Col. 3, lines 2-10) as taught by Zeng et al.

Response to Arguments

11. Applicant's arguments with respect to claims 1-5 and 20 have been considered but are moot in view of the new ground(s) of rejection.

12. Applicant's arguments, see Page 2-3, filed 23 January 2008, with respect to the specification have been fully considered and are persuasive. The objection of the specification has been withdrawn.

13. Applicant's arguments, see Page 9, filed 23 January 2008, with respect to the drawings have been fully considered and are persuasive. The objection of the drawings has been withdrawn.

14. Applicant's arguments, see Page 13, filed 23 January 2008, with respect to claims 13-14 have been fully considered and are persuasive. The 35 U.S.C. 112, Second Paragraph rejection of claims 13-14 has been withdrawn.

15. Applicant's arguments filed 23 January 2008 have been fully considered but they are not persuasive.

With respect to claim 13, the Applicant argues that the claim would be allowable when the 35 U.S.C. 112, Second Paragraph rejection is overcome since this is the only rejection made against the claim. The Examiner disagrees. As noted in the Non-Final Office Action mailed 1 November 2007, claim 13 was rejected under 35 U.S.C. 103(a) as being unpatentable over Turbell et al. (p865) as applied to claim 6 above, and further in view of in view of Katsevich (6,574,299) and Zeng et al. Therefore a rejection other than the 35 U.S.C. 112, Second Paragraph rejection was applied to the claim and the claim remains rejected.

With respect to at least claim 6, the Applicant argues that Turbell et al. (p865) fails to disclose reconstructing the measuring values as a function of corresponding projection angles to generate an image indicative of the examination zone. The Examiner disagrees. Turbell et al. (p865) discloses the measured values are acquired during a helical scan of the object at corresponding projection angles (Figure 1). The images (Figures 6-8) are reconstructed by a backprojection method (Step 4 of introduction, backprojecting along the corresponding ray) in which each of the acquired data sets are backprojected as a function of the angle at which they

were acquired (corresponding ray is a acquired as a function of projection angle), i.e. the corresponding projection angle. Therefore Turbell et al. (p865) does disclose reconstructing the measuring values as a function of corresponding projection angles to generate an image indicative of the examination zone and the claims remain rejected.

With respect to at least claim 6, the Applicant argues that Katsevich (6,574,299) fails to disclose reconstructing the measuring values as a function of corresponding projection angles to generate an image indicative of the examination zone. The Examiner disagrees. Katsevich (6,574,299) discloses the measured values are acquired during a scan of the object at corresponding projection angles (Figure 1). The images (Figure 1, images reconstructed by image reconstruction computer (4) are displayed on display (6)) are reconstructed (Col. 1, lines 5-9) by a backprojection method (Figure 2, item 50) in which each of the acquired data sets are backprojected as a function of the angle at which they were acquired (See Figure 2, including items 10, 50 and 60) i.e. the corresponding projection angle. Therefore Katsevich (6,574,299) does disclose reconstructing the measuring values as a function of corresponding projection angles to generate an image indicative of the examination zone and the claims remain rejected.

With respect to at least claim 15, the Applicant argues that Katsevich (6,574,299) fails to disclose reconstructing the first voxel as a function of a first set of corresponding projection angles indicative of angles at which a radiation beam traverses the first voxel. The Examiner disagrees. Katsevich (6,574,299) discloses reconstructing (Figure 2 which shows an overview of the steps of the inventive reconstruction process) the first voxel (Step 51, point x fixed for

reconstruction of voxel) as a function of a first set of corresponding projection angles (Figure 2, steps 10 and 60 are projections obtained at different corresponding projection angles so reconstruction is a function of a first set of corresponding projection angles) indicative of angles at which a radiation beam traverses the first voxel (Figure 1, measurements obtained in projections are obtained by radiation beam traversing voxel at point x from different angles). Therefore Katsevich (6,574,299) does disclose reconstructing the first voxel as a function of a first set of corresponding projection angles indicative of angles at which a radiation beam traverses the first voxel and the claims remain rejected.

With respect to at least claim 17, the Applicant argues that Katsevich (6,574,299) fails to disclose a reconstructor that integrates the measuring values over projection angles corresponding to angles enclosed by a PI line of an object point projected in a plane perpendicular to an axis of rotation. The Examiner disagrees. Katsevich (6,574,299) discloses the PI line (Col. 5, lines 36-44 and Figure 4) and a reconstructor (4). When reconstructing a point (x), projections containing measured values (D_f) are utilized. The projections containing the measured values are obtained throughout the corresponding projection angles to the source positions s_b to s_t on a source trajectory which form the PI parametric interval (Col. 5, lines 36-44 and Figure 4). The projection angle of a projection is defined by the angle of rotation in the y_1y_2 plane about the y_3 rotation axis. The y_1y_2 plane is perpendicular to the y_3 axis (Equation 1 and Figure 1). The reconstructor (4) implements the method of the embodiment (a filtered backprojection method utilizing an inversion formula, equations 10 or 13 for example) which performs the reconstruction by integrating measured values over projection angles enclosed by

PI lines ($\int_{PI(x)}$). Therefore Katsevich (6,574,299) does disclose a reconstructor that integrates the measuring values over projection angles corresponding to angles enclosed by a PI line of an object point projected in a plane perpendicular to an axis of rotation and the claims remain rejected.

With respect to at least claims 1 and 3, the Applicant argues that there is no motivation to combine Katsevich (6,574,299) with Turbell et al. (p865) The Applicant particularly argues the assertion "that the partial derivative has anything to do with reducing scanning times". The Examiner disagrees. The Examiner notes that the partial derivative of the measured values cited in step 35 is but one step 30 (the preparation for filtering, see Figure 9) which in turn is but one step in the basic reconstruction process steps of the invention (See Figure 2). As stated in Katsevich (6,574,299) "the sixth objection of the invention is to provide an improved process and system for reconstructing images of which spirally scanned objects with larger pitch, leading to ***faster scans*** than previous techniques" (Col. 2, lines 43-46) for which the partial derivative is a process step in the overall improved process. Therefore Katsevich (6,574,299) does teach the assertion that the partial derivative has to do with reducing scanning times and the claims remain rejected.

Applicant's arguments, see page 17, lines 23-25, filed 23 January 2008, with respect to at least the rejection(s) of claim(s) 1 and 3 under 35 U.S.C. 103(a) have been fully considered and are persuasive. Therefore, the rejection has been withdrawn. However, upon further

consideration, a new ground(s) of rejection is made in view of the 35 U.S.C 103(a) rejection of Katsevich (2002).

Applicant's arguments, see page 18, lines 14-16 and 22-23, filed 23 January 2008, with respect to the rejection(s) of claim(s) 4 under 35 U.S.C. 103(a) have been fully considered and are persuasive. Therefore, the rejection has been withdrawn. However, upon further consideration, a new ground(s) of rejection is made in view of the 35 U.S.C. 103(a) rejection Katsevich (2002) in view of Hsieh.

Applicant's arguments, see page 19, lines 11-12, filed 23 January 2008, with respect to the rejection(s) of claim(s) 14 under 35 U.S.C. 103(a) have been fully considered and are persuasive. Therefore, the rejection has been withdrawn. However, upon further consideration, a new ground(s) of rejection is made in view of 35 U.S.C 102(b) rejection of Katsevich (2002).

With respect to claim 12, the Applicant argues that the claim depends from claim 6 and should be allowed based upon its dependency of on claim 6. The Examiner disagrees. As noted above, the applicant's arguments with respect to claim 6 where not persuasive. Therefore the Applicant's arguments are not persuasive and the claim remains rejected.

Conclusion

Any inquiry concerning this communication or earlier communications from the examiner should be directed to JOHN M. CORBETT whose telephone number is (571)272-8284. The examiner can normally be reached on M-F 8 AM - 4:30 PM.

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Edward J. Glick can be reached on (571) 272-2490. The fax phone number for the organization where this application or proceeding is assigned is 571-273-8300.

Information regarding the status of an application may be obtained from the Patent Application Information Retrieval (PAIR) system. Status information for published applications may be obtained from either Private PAIR or Public PAIR. Status information for unpublished applications is available through Private PAIR only. For more information about the PAIR system, see http://pair-direct.uspto.gov. Should you have questions on access to the Private PAIR system, contact the Electronic Business Center (EBC) at 866-217-9197 (toll-free). If you would like assistance from a USPTO Customer Service Representative or access to the automated information system, call 800-786-9199 (IN USA OR CANADA) or 571-272-1000.

/J. M. C./
Examiner, Art Unit 2882

/C. G. K./

/Edward J Glick/
Supervisory Patent Examiner, Art Unit 2882